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**Transmission and Multiplexing (TM);  
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Synchronous Digital Hierarchy (SDH);  
System performance monitoring parameters of SDH DRRS**

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## Foreword

This European Standard (Telecommunications series) has been produced by ETSI Technical Committee Transmission and Multiplexing (TM).

The present document describes the performance monitoring functional architecture and requirements which are specific to the Digital Radio Relay System (DRRS) Network Elements (NE) that use the Synchronous Digital Hierarchy (SDH) multiplexing structure.

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Date of adoption of this EN:	18 September 1998
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# 1 Scope

The present document defines the additional specific performance monitoring functional architecture and requirements to be used for management of Digital Radio Relay Systems (DRRS) which use the Synchronous Digital Hierarchy (SDH).

Considering that:

- ETS 300 635 [4] and ITU-R Recommendation F.750 [3] define the SDH radio specific functional blocks for transmission at STM-n data rate;
- ETS 300 785 [5] and ITU-R Recommendation F.750 [3] define the SDH radio specific functional blocks for transmission at Synchronous Transport Module 0 (STM-0) data rate;
- EN 301 167 [6], ETS 300 417 [7], ITU-T Recommendations G.783 [1] and G.784 [2] define the performance monitoring architecture and requirements for generic functional blocks used on SDH DRRS and other SDH equipment;
- ITU-T Recommendation M.3010 [8] defines the standardized logical and functional Telecommunication Management Network (TMN) architecture.

The present document defines:

- the specific performance primitives and events to be used for performance management of radio specific functional blocks;
- the general requirements for history treatment associated to each performance event;
- the general requirements for thresholding treatment associated to each performance event;
- the specific transmission quality information which is required for maintenance purpose.

The present document does not define:

- the F interface performance monitoring;
- the performance monitoring related to non radio specific functional blocks;
- the information model to be used on Q interface which is on the study in TC TMN, (work item DEN/TMN-0006, see bibliography).
- the protocol stack to be used for the message communication function;
- any radio specific additional performance parameter to be used at network level management.

The present document applies on each SDH DRRS independently of the transmission data rate supplied (STM-n or STM-0).

The parameters defined in the present document are only intended to be used for radio equipment maintenance.

The present document should provide guidance and supporting information for the definition of object-oriented models within SDH DRRS.

It is not required for that equipment developed prior to the present document to be fully compliant with the present document.

## 2 References

References may be made to:

- a) specific versions of publications (identified by date of publication, edition number, version number, etc.), in which case, subsequent revisions to the referenced document do not apply; or
- b) all versions up to and including the identified version (identified by "up to and including" before the version identity); or
- c) all versions subsequent to and including the identified version (identified by "onwards" following the version identity); or
- d) publications without mention of a specific version, in which case the latest version applies.

A non-specific reference to an ETS shall also be taken to refer to later versions published as an EN with the same number.

- [1] ITU-T Recommendation G.783 (1994): "Characteristics of synchronous digital hierarchy (SDH) equipment functional blocks".
- [2] ITU-T Recommendation G.784 (1994): "Synchronous digital hierarchy (SDH) management".
- [3] ITU-R Recommendation F.750: "Architectural and functional aspects of radio-relay systems for SDH-based networks".
- [4] ETS 300 635: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH); SDH Radio specific functional blocks for transmission of M x STM-N".
- [5] ETS 300 785: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH); SDH Radio specific functional blocks for transmission of M x sub-STM-1".
- [6] EN 301 167: "Transmission and Multiplexing (TM); Management of Synchronous Digital Hierarchy (SDH) transmission equipment; Fault management and performance monitoring; Functional description".
- [7] ETS 300 417: "Transmission and Multiplexing (TM); Generic functional requirements for Synchronous Digital Hierarchy (SDH) equipment".
- [8] ITU-T Recommendation M.3010: "Principles for a Telecommunications management network".
- [9] ITU-T Recommendation G.826: "Error performance parameters and objectives for international constant bit rate digital paths at or above the primary rate".
- [10] ITU-T Recommendation G.EPMRS: "Error Performance Events for SDH Multiplex Sections".
- [11] ETS 300 411: "Performance monitoring information model for the Network Element (NE) view".
- [12] ITU-T Recommendation G.774.01: "Synchronous Digital Hierarchy (SDH) performance monitoring for the network element view".
- [13] ITU-T Recommendation G.707 (1996): "Network node interface for the synchronous digital hierarchy (SDH)".
- [14] Void.
- [15] TR 101 035: "Transmission and Multiplexing (TM); Synchronous Digital Hierarchy (SDH) aspects regarding Digital Radio Relay Systems (DRRS)".
- [16] ITU-T Recommendation M.20: "Maintenance philosophy for telecommunications networks".
- [17] ITU-T Recommendation G.861: "Principles and guidelines for the integration of satellite and radio systems in SDH transport networks".

## 3 Symbols and abbreviations

### 3.1 Symbols

For the purposes of the present document, the following symbols apply:

dB	decibel
dBm	decibel relative to 1 milliWatt

### 3.2 Abbreviations

For the purposes of the present document, the following abbreviations apply:

ATPC	Automatic Transmit Power Control
BBE	Background Block Error
DRRS	Digital Radio Relay System
ES	Errored Second
EW	Early Warning
FEC	Forward Error Correction
FSRD	Failed Switch Request Duration
FSRC	Failed Switch Request Count
HBER	High Bit Error Rate
HO	High Order
IF	Intermediate Frequency
LBER	Low Bit Error Rate
LOS	Loss of Signal
MCF	Message Communication Function
MS	Multiplex Section
MSA	Multiplex Section Adaptation
MST	Multiplex Section Termination
NE	Network Element
OS	Operating System
POH	Path OverHead
PM	Performance Monitoring
PSA	Protection Switch Actual
PSAC	Protection Switch Actual Count
PSAD	Protection Switch Actual Duration
PSR	Protection Switch Request
RF	Radio Frequency
RL	Received Level
RLTD	Received Level Tide Mark
RLTM	Received Level Tide Mark
RLTS	Received Level Threshold Second
ROHA	Radio OverHead Access
RPS	Radio Protection Switching
RRR	Radio Relay Regenerator
RRT	Radio Relay Terminal
RS	Regenerator Section
RSOH	Regenerator Section OverHead
RSPI	Radio Synchronous Physical Interface
RST	Regenerator Section Termination
SDH	Synchronous Digital Hierarchy
SES	Severely Errored Second
SEMF	Synchronous Element Management Function
SF	Signal Fail
STM-n	Synchronous Transport Module n
Sub-STM-1	Sub-Synchronous Transport Module 1 (also defined as STM-0 in ITU-T Recommendation G.861 [17])
TL	Transmitted Level

TLTD	Transmitted Level Tide Mark
TLTM	Transmitted Level Tide Mark
TLTS	Transmitted Level Threshold Second
TMN	Telecommunication Management Network
UAS	UnAvailable Second
UAT	UnAvailable Time
VC-n	Virtual Container n

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## 4 Introduction

The SDH multiplexing frame structure allows in-service quality transmission monitoring at different levels such as regenerator and multiplex sections and low/high order paths.

SDH Performance Monitoring (PM) is described starting from the definition of the performance primitives, events and parameters and defining the PM data collection and history treatment together with the way to present PM information to a managing system at a Q3 interface.

The whole matter is covered by several ITU-T Recommendations and ETSI standards e.g. ITU-T Recommendations G.783 [1], G.784 [2], G.826 [9], G.EPMRS [10], and G.774.01 [12]; EN 301 167 [6], ETS 300 411 [11] and ETS 300 417 [7].

SDH radio Network Elements (NE) may terminate, depending on applications, regenerator and multiplex sections and also high/low order paths. For each one of the above SDH layers implemented inside a SDH radio NE, the associated standardized PM shall be implemented.

Signal transmission on microwave radios may be affected by mid-air propagation phenomena that may result in transmission quality degradation. In order to counteract such typical radio feature several counter measures are or may be implemented inside radio transmission equipment.

The close relationship between transmission quality and radio link propagation cannot be well understood if the PM is limited only to quality of service.

In particular it is not possible, for a given measured quality, to discriminate among errors due to equipment degradations, countermeasure unefficiency and unusual or unpredicted bad propagation.

From such a reason the present document covers the need to have radio specific performance parameters to be used in close conjunction with the ordinary ones related to quality transmission: Severely Errored Second (SES), Errored Second (ES), Background Block Error (BBE) and UnAvailable Second (UAS).

Radio specific PM defines new radio specific performance primitives, events and parameters with associated requirements for data collection, threshold and history treatment.

Radio specific PM deals with monitoring of the radio specific functional blocks Radio Synchronous Physical Interface (RSPI) and Radio Protection Switching (RPS) as defined in ETS 300 635 [4], ETS 300 785 [5] and ITU-R Recommendation F.750 [3].

Clause 5 describes the general architecture of the radio specific PM process.

All the radio specific performance parameters defined in the present document are not required to meet quality objectives. Their meaning is consistent only in the hops or link which they refer to. Comparisons among different hops or links are not meaningful. A true performance comparison among different hops or links can be done only on the base of the generic SDH quality of service parameters like ES, SES, BBE and UAS.

From a management point of view the following applications may be envisaged:

- maintenance application:

The presence of the 15 minutes register counters with associated threshold crossing control may be used to trigger threshold crossing notifications to a managing system. This process may be helpful to indirectly localize possible degradations of hardware devices like ATPC devices, feeders and antennas for example.

- SDH transmission quality parameters qualification:

The presence of the 15 minutes and 24 hours current register counters like SES, ES, BBE and UAS associated for each regenerator and multiplex sections terminated in a Radio NE allows to have transmission quality monitoring of the same sections. The association of radio specific counters on registers of the same period allows to qualify them.

In particular the values of radio specific counters may give indications on occurrence of propagation fading and switching activity during these periods helping in the distinction between quality degradation due to equipment or propagation.

- long term statistics:

The presence of 24 hours history register radio specific counters together with the possibility to transfer their associated values to a managing system allows the collection at OS level of long term statistics.

This information may also be used to verify the existing propagation prediction methods which are usually used for link design or develop new ones.

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## 5 Functional architecture

The functional architecture of the radio specific PM (data collection, history and threshold treatment) is compliant to ITU-T Recommendation G.784 [2] and EN 301 167 [6].

This clause does not define any additional functional architecture requirements.

The functional architecture is reported in the informative annex C for the reader convenience.

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## 6 Radio specific maintenance parameters

### 6.1 Radio Synchronous Physical Interface (RSPI) performance management

#### 6.1.1 Performance primitives

##### 6.1.1.1 Received Level (RL)

The RL is the level of the estimated received power at the input of the receiver and may be used to understand if a predefined period has been affected by fading activity. It may be also used to identify some permanent loss of received power due to hardware failures.

It must be outlined that this level is an estimation of the received power and that it may be affected by a certain amount of inaccuracy that is system dependent.

Moreover the interpretation of the associated values depends on several factors:

- the type of transmission used, i.e. bi-carriers, mono carrier systems;
- the fact that it is usually associated to a wide-band measure;
- the employed frequency.

The RL shall be a performance primitive available at the S50 reference point of the RSPI functional block.

This level shall be readable by a managing system on request.

The parameter unit shall be expressed in dBm and represented by the rounded nearest integer.

In the case that an Intermediate Frequency (IF) combiner is used as a fading countermeasure, only one performance primitive is required.

In this case this performance primitive is represented by either the level of the combined signal or by the level of the best single received input signals according to their availability.

In the case that STM-4 reception is implemented by several receivers (even if it is modelled by one single RSPI functional block) then one RL shall be monitored per each receiver implementing the block. On the consequence the S50 reference point may provide a multiple RL performance data table.

### 6.1.1.2 Transmitted Level (TL)

This subclause applies only when the Automatic Transmit Power Control (ATPC) is present. There are no requirements on TL when the ATPC is not present.

The TL is the level of the estimated transmitted power at the transmitter output. It may be used to monitor the ATPC of a transmitter.

It may also be used to identify periods of fading activity.

NOTE: Currently implemented ATPC controls are of two kinds:

**Continuous power tracking** where a control loop keeps the receiver level constant from the activation threshold down to a fading attenuation equal to the ATPC range, in this case the TL may assume any value within the ATPC range.

**Step control power** where only one or few power steps may be activated by the receiver level thresholds without any control loop, in the latter case the TL assumes discrete values within the ATPC range.

Similar considerations can be done for the TL as reported in subclause 6.1.1.1 for the RL.

The TL shall be a performance primitive available at S50 reference point of the RSPI functional block.

This level shall be readable by a managing system on request.

The TL level is represented by two values:

- an integer fixed value expressed in dBm defining the nominal i.e. the maximum transmitted power value which is equipment dependent;
- an integer offset value expressed in dB representing the variation with respect to the nominal value.

In the case that STM-4 transmission is implemented by several transmitters (even if it is modelled by one single RSPI functional block) then one TL shall be monitored per each transmitter implementing the block. On the consequence the S50 reference point may provide a multiple TL performance data table.

## 6.1.2 Performance events

### 6.1.2.1 Received Level Threshold Second (RLTS)

The RLTS event is defined as a one second period during which the detected RL value is below a predefined threshold.

The associated predefined threshold shall be given in dBm and it is a characteristic of the event definition. The facility of assigning the threshold value by the managing system shall be mandatory and may also be settable locally.

For any RL performance primitive at least two RLTS events are required corresponding to two different threshold values. A number  $n$  of RLTS events with  $n$  greater than two is optional.

The current value of the counter associated with a RLTS shall be readable by a managing system on request.

In the case that a threshold associated to a RLTS counter is changed then the current value of the counter shall be reset to zero.

### 6.1.2.2 Received Level Tide Mark (RLTM)

The RLTM is a mechanism that records the maximum and the minimum value reached by the RL during a measurement period. The tide mark values are automatically reset to the RL current value assumed at the beginning of each measurement period.

The RLTM is therefore composed by two values: the  $RL_{\max}$  for the maximum value and the  $RL_{\min}$  for the minimum value.

The comparison between the RL current value and the  $RL_{\max}$  and  $RL_{\min}$  values shall be performed on a second basis.

When the current RL value is greater than the  $RL_{\max}$  value then the  $RL_{\max}$  value is updated equal to the RL current value. When the current RL value is lower than the  $RL_{\min}$  value then the  $RL_{\min}$  value is updated equal to the RL current value.

The RLTM is an optional feature.

### 6.1.2.3 Transmitted Level Threshold Second (TLTS)

This subclause applies only when the ATPC is present.

The TLTS event is defined as a one second period during which the detected TL value is greater than a predefined threshold.

The associated predefined threshold shall be given in dB and it is a characteristic of the event definition. The facility of assigning the threshold value by the managing system shall be mandatory and may also be settable locally.

**NOTE:** When ATPC is supplied by one or more transmitter power steps (see note in subclause 6.1.1.2) the threshold assignment to any value within one power step will give the same results. For example, in the case of one step, the result is the activation time of the ATPC.

For any TL performance primitive one TLTS event is required.

One additional TLTS event is optional.

The current value of the counter associated with a TLTS shall be readable by a managing system on request

In the case that a threshold associated to a TLTS counter is changed then the current value of the counter shall be reset to zero.

#### 6.1.2.4 Transmitted Level Tide Mark (TLTM)

The TLTM is a mechanism that records the maximum or minimum value reached by the TL during a measurement period. The tide mark values are automatically reset to the TL current value assumed at the beginning of each measurement period.

The TLTM is therefore composed by two values: the  $TL_{max}$  for the maximum value and the  $TL_{min}$  for the minimum value.

The comparison between the TL current value and the  $TL_{max}$  and  $TL_{min}$  values shall be performed on a second basis.

When the current TL value is greater than the  $TL_{max}$  value then the  $TL_{max}$  value is updated equal to the TL current value. When the current TL value is lower than the  $TL_{min}$  value then the  $TL_{min}$  value is updated equal to the TL current value.

The TLTM is an optional feature.

#### 6.1.3 Performance data collection and history treatment

Storage requirements of RSPI performance events in the 15 minutes and 24 hours current and history registers are reported in table 1.

**Table 1: Storage requirements for RSPI performance events**

Performance event	Current value	15 minute current register	15 minute history registers	24 hour current register	24 hour history register
RL	R	-	-	-	NR
RLTS-1	-	R	R	R	R
RLTS-2	-	R	R	R	R
RLTS-n	-	O	R*	R*	R*
RLTM	-	O	R*	R*	R*
TL	R	-	-	-	NR
TLTS-1	-	R	R	R	R
TLTS-2	-	O	R*	R*	R*
TLTM	-	O	R*	R*	
NOTE: R = Required - = Not Applicable O = Optional NR = Not Required R* = Required only if supported in the 15 minutes current register.					

#### 6.1.4 Performance data threshold treatment

Threshold treatment requirements for performance events are reported in table 2.

**Table 2: Threshold control requirement for RSPI performance events**

Performance event	15 minute threshold control	24 hour threshold control
RL	NR	NR
RLTS-1	R	R
RLTS-2	NR	NR
RLTS-n	NR	NR
RLTM	NR	NR
TL	NR	NR
TLTS-1	R	R
TLTS-2	NR	NR
TLTM	NR	NR
NOTE: R = Required NR = Not required		

## 6.2 Radio Protection Switching (RPS) performance management

### 6.2.1 Performance primitives

#### 6.2.1.1 Protection Switch Actual (PSA)

APSA represents any actual switch from a protected (working) channel to a protecting (stand-by) channel.

This performance primitive shall be reported to the Synchronous Element Management Function (SEMF) at reference point S 51 of the RPS functional block.

#### 6.2.1.2 Protection Switch Request (PSR)

A PSR represents any activation of a switch initiation criteria which may lead to automatic switches from a working channel to a stand-by channel and vice-versa.

This performance primitive shall be reported to the SEMF at reference point S 51 of the RPS functional block.

### 6.2.2 Performance events

#### 6.2.2.1 Protection Switch Actual Count (PSAC)

A PSAC represents the number of PSA occurrences in a time period.

This time period can vary between zero and 15 minutes or 24 hours for the 15 minute or 24 hour current register respectively and represents the elapsed time since the last reset of the count.

This time period is 15 minutes or 24 hours for 15 minute or 24 hour history registers respectively.

A PSAC is defined for any protected or protecting channel involved in a M: N protection scheme where M is the number of the protecting channels and N is the number of the protected ones.

For a protected channel the PSAC is the number of any actual switch from this channel to any protecting channel. For a protecting channel the PSAC is the number of any actual switch from any protected channel to this channel.

For 1+1 and 1:N protection scheme this event is only required for the protected channel.

The current value of the counter associated with a PSAC shall be readable by a managing system on request.

Table 3 summarizes the required conditions for generating the PSAC event of the RPS functional block.

**Table 3: PSAC event generation requirements**

Channel	Protection scheme		
	1+1	1:n	m(m>1):n
<b>protected (working)</b>	R	R	R
<b>protecting (stand-by)</b>	NR	O	R
NOTE: R = Required NR = Not required O = Optional			

### 6.2.2.2 Failed Switch Request Count (FSRC)

A FSRC represents the number of the occurrences in a time period of the following events:

- A: a PSR is activated on a working channel and the protecting channels are not available.
- B: a working channel is restored from a protecting channel while a PSR is still active on the channel.

This time period can vary between zero and 15 minutes or 24 hours for the 15 minute or 24 hour current register respectively and represents the elapsed time since the last reset of the count.

This time period is 15 minutes or 24 hours for 15 minute or 24 hour history registers respectively.

A FSRC is defined only for working channels.

For 1+1 protection scheme this event is optional.

When an activation criterion is already present on a channel, the activation of another one will not increment the counter.

The current value of the counter associated with a FSRC shall be readable by a managing system on request.

Table 4 summarizes the required conditions for generating the FSRC event of the RPS functional block.

**Table 4: FSRC event generation requirements**

Channel	Protection scheme	
	1+1	m:n
<b>protected (working)</b>	O	R
<b>protecting (stand-by)</b>	NR	NR
NOTE: R = Required NR = Not required O = Optional		

### 6.2.2.3 Protection Switch Actual Duration (PSAD)

A PSAD event count is the number of seconds, in a time period, for which a channel is in the switched status for at least a fraction of one second.

For a protected channel the switched status means that its associated traffic is carried on a protecting channel.

For a protecting channel the switched status means that it is carrying traffic from a protected channel.

This time period can vary between zero and 15 minutes or 24 hours for the 15 minute or 24 hour current register respectively and represents the elapsed time since the last reset of the count.

This time period is 15 minutes or 24 hours for 15 minute or 24 hour history registers respectively.

A PSAD event is defined for any protected or protecting channel involved in a M:N protection scheme.

For 1+1 protection scheme this event is optional.

In the case of fixed 1+1 non-revertive switching schemes this event has no meaning and is not required.

In the case of selectable revertive/non-revertive 1+1 switching schemes this event is optional. However, if the non-revertive mode is active, an output for this event shall not be generated.

In case of switches arising from management operations an output of this event shall not be generated.

The current value of the counter associated with a PSAD shall be readable by a managing system on request.

Table 5 summarizes the required conditions for generating the PSAD event of the RPS functional block.

**Table 5: PSAD event generation requirements**

Channel	Protection scheme		
	1+1 revertive	1+1 non-revertive	m:n
<b>protected (working)</b>	O	NR	R
<b>protecting (stand-by)</b>	O	NR	R
NOTE: R = Required NR = Not required O = Optional			

#### 6.2.2.4 Failed Switch Request Duration (FSRD)

A FSRD event is the count of the number of seconds in a time period for which, at least for a fraction of one second, a protection switch request is detected active on a channel carrying regular traffic and the request cannot be serviced.

This time period can vary between zero and 15 minutes or 24 hours for the 15 minute or 24 hour current register respectively and represents the elapsed time since the last reset of the count.

This time period is 15 minutes or 24 hours for 15 minute or 24 hour history registers respectively.

A FSRD event is defined only for working channels.

For 1+1 protection scheme this event is optional.

The current value of the counter associated with a FSRD shall be readable by a managing system on request.

Table 6 summarizes the required conditions for generating the FSRD event of the RPS functional block.

**Table 6: FSRD event generation requirements**

Channel	Protection scheme	
	1+1	m:n
<b>protected (working)</b>	O	R
<b>protecting (stand-by)</b>	NR	NR
NOTE: R = Required NR = Not required O = Optional		

### 6.2.3 Performance data collection and history treatment

Performance data collection and history treatment principles are described in annex C.

Storage requirements of RPS performance events in the 15 minutes and 24 hours current and history registers are reported in table 7.

Storage requirements apply only for those events that are generated according to tables 3, 4, 5 and 6.

**Table 7: Storage requirements for RPS performance events**

Performance event	15 minute current register	15 minute history registers	24 hour current register	24 hour history register
<b>PSAC</b>	R	R	R	R
<b>FSRC</b>	R	R	R	R
<b>PSAD</b>	R	R	R	R
<b>FSRD</b>	R	R	R	R
NOTE: R = Required				

## 6.2.4 Performance data threshold treatment

Threshold treatment requirements for performance events are reported in table 8.

Threshold treatment requirements apply only for those events that are generated according to tables 3, 4, 5 and 6.

**Table 8: Threshold control requirements for RPS performance events**

Performance event	15 minute threshold control	24 hour threshold control
PSAC	O	O
PSAD (working)	O	O
PSAD (stand-by)	R	R
FSRC	O	O
FSRD	O	O
NOTE: R = Required O = Optional		

## 6.3 Radio OverHead Access (ROHA) performance management

There are no performance requirements for the ROHA functional block.

# 7 Radio specific transmission quality monitoring

SDH DRRS are parts of the SDH network and may be used to implement Regenerator Section (RS) and Multiplex Section (MS) functions.

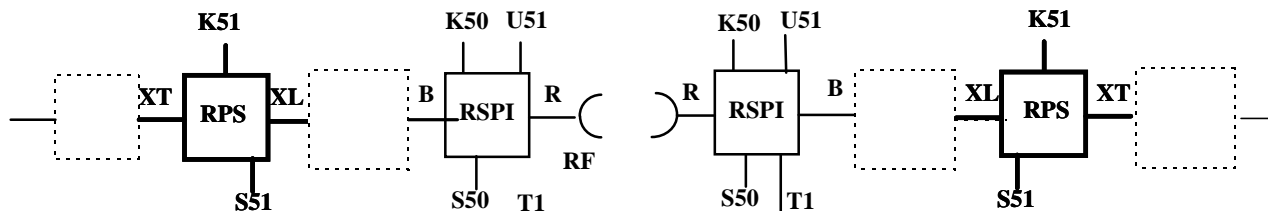
One necessity is to provide the performance of the radio link section in order to compare the performance of different sections of the network (for example radio link and optical link). The information derived for each type of section shall be comparable, therefore the parameters and the methodology used to evaluate them shall be consistent and shall be the results of similar calculation processes.

For the RS and MSs implemented by DRRS the parameters and the methodology used to provide performance monitoring are defined in EN 301 167 [6]. The evaluation of these parameters is required for RS and MS.

The RS and MS shall be implemented as defined in ETS 300 635 [4] and ETS 300 785 [5].

To monitor the performance of a protected section it may be useful to have a radio specific performance monitoring on reference point XT of the RPS functional block as an option. Due to the fact that the allocation of the RPS functional block can be different according to ETS 300 635 [4], the use and implementation of this performance monitoring functionality can also be different.

Figure 1 shows the location of reference point XT, not depending on the allocation of the RPS functional block.



**Figure 1: Location of reference point XL at the RPS functional block**

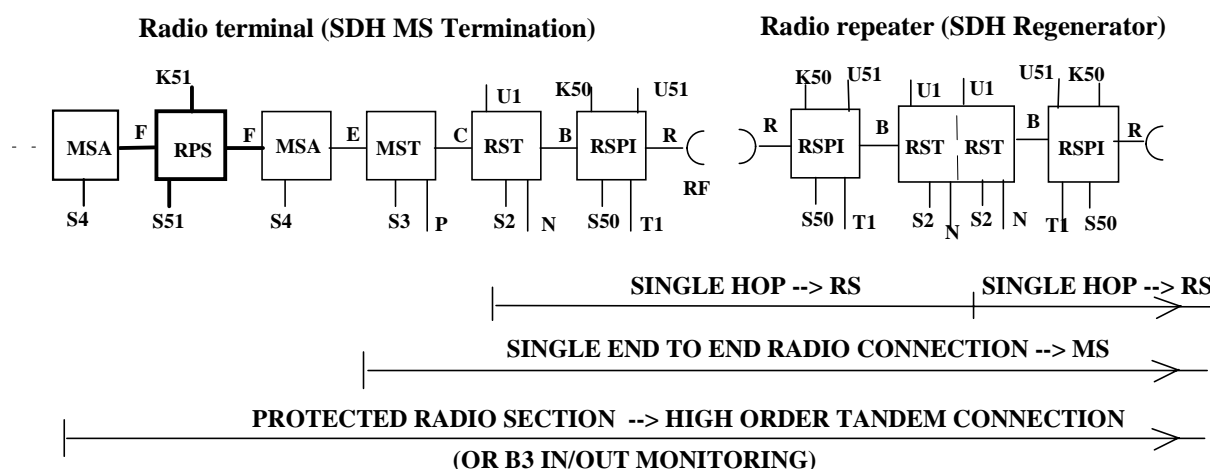
The parameters and methodology used to provide this performance monitoring shall be the same as for RS and MS.

The possible allocation of RPS functional block according to ETS 300 635 [4] and possible implementations of quality monitoring at actual XT reference points are shown in annex A.

## Annex A (informative): Description of radio specific performance monitoring at reference point XT dependent on the allocation of RPS functional block

According to the informative annex of ETS 300 635 [4] the allocation of RPS functional block can be different. Figures A.1, A.2, A.3 and A.4 show four types of implementation to illustrate whether it could be necessary to have radio specific performance transmission quality monitoring or not.

RPS of types A and B reported by ETS 300 635 [4] are suitable only in radio terminals which terminate a MS, meanwhile types C and D may be used in both cases of radio terminals which are seen as terminals of a MS or a RS only.



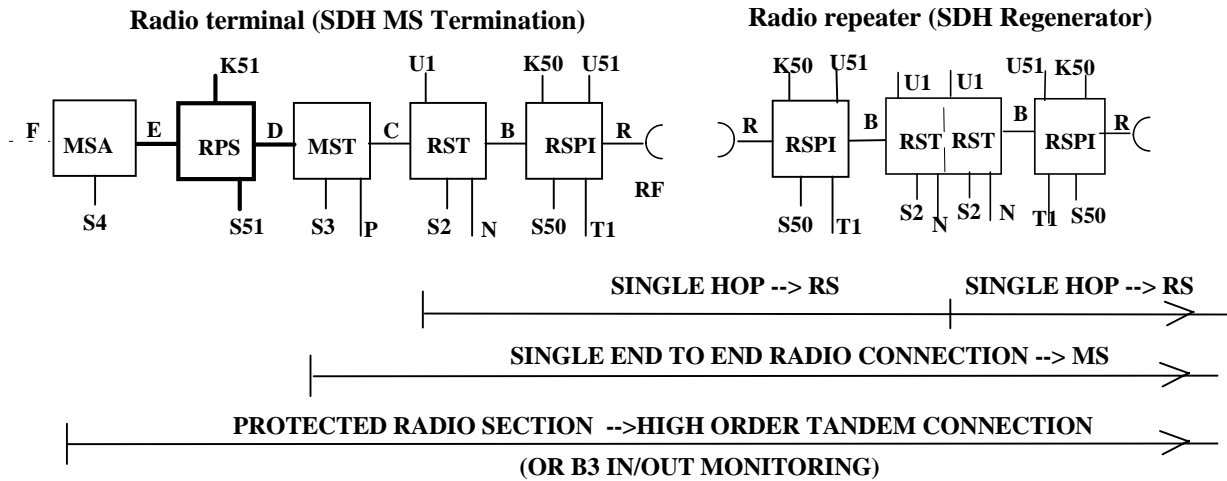
**Figure A.1: Allocation of RPS functional block type A of ETS 300 635 [4]**

In case of RPS functional block allocation as shown in figure A.1, single radio connections are monitored hop by hop as RSs and end to end as MS.

When it is required to monitor the performance after reference point F, as there is no possibility given by RST or MST to monitor the performance of the protected section, two processes may, in this case, be possible:

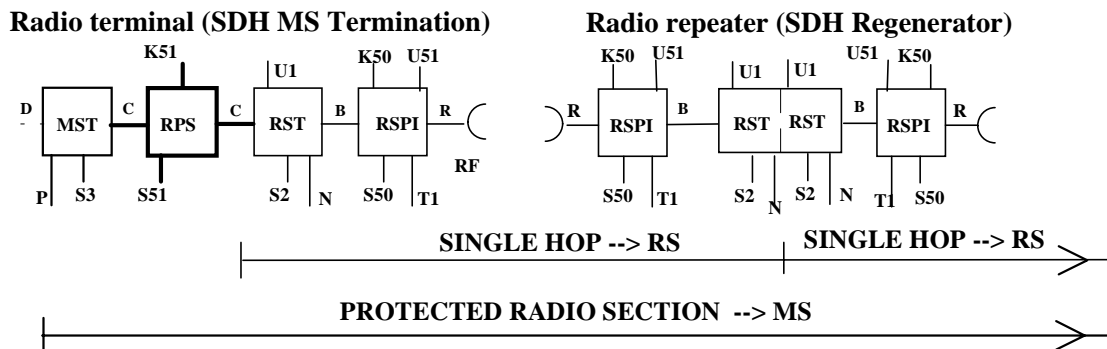
- the first process is to evaluate separately the quality of the VC-4 through B3 parity monitoring at the input and at the output from the protected radio section and let the OS to provide the difference;
- the second process is to implement an High Order (HO) tandem connection monitoring as foreseen by ITU-T Recommendations G.707 [13] and G.783 [1].

**NOTE:** In case the radio connection is embedded into an already in operation, longer HO tandem connection, the radio section monitoring may still be performed, in agreement with the network operator, as an additional HO tandem connection using one of the user bytes of the VC-4 Path OverHead (POH) (i.e. F2 and Z4) in place of N1.

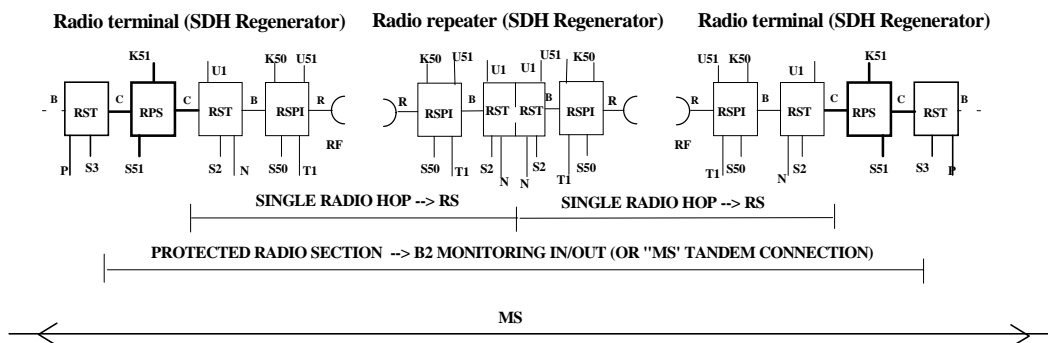


**Figure A.2: Allocation of RPS functional block type B of ETS 300 635 [4]**

In case of RPS functional block allocation as shown in figure A.2 it may be necessary to monitor the performance at reference point E, as there is no possibility given by RST or MST to monitor the performance of the protected section, the same methodology of RPS type A shown in figure A.1 may be applied.



**a) case with termination of MS**



**b) case without termination of MS**

**Figure A.3: Allocation of RPS functional block type C of ETS 300 635 [4]**

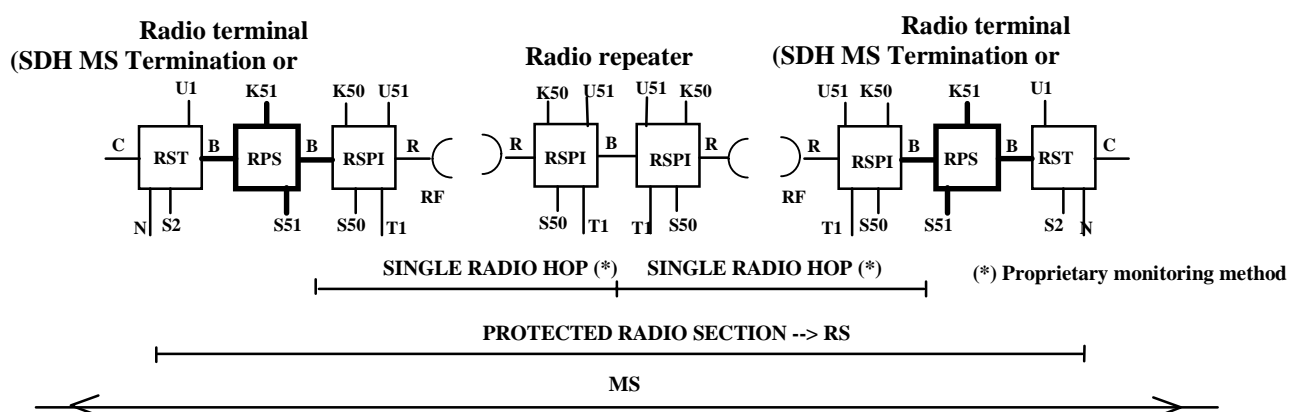
In case of RPS functional block allocation as shown in figure A.3 it may be necessary to monitor the performance at reference point C. If the radio terminal is configured as MST as shown in figure A.3a) the performance of the protected section are coincident with that of the MS itself.

If the radio terminal is configured simply as a RS, as shown in figure A.3b), the performance of the protected section may be monitored through B2 bytes at the input and output of the RPS.

Two processes may, in this case, be possible for the radio protected section quality:

- the first process is to evaluate separately the quality of the STM-N signal at the input and at the output from the protected radio section and let the OS to provide the difference;
- the second process is to send forward, through a media dependent byte of the Radio Section OverHead (RSOH), the information of input errored block towards the far end terminal, which may evaluate the difference with the output quality and directly providing the element manager with the actual quality of the protected radio section.

This methodology of "MS tandem connections", is in principle similar to the HO tandem connections foreseen by ITU-T but no parity recovery algorithm, as that of N1 byte of VC4 POH, is required.



**Figure A.4: Allocation of RPS functional block type D of ETS 300 635 [4]**

In case of RPS functional block allocation as shown in figure A.4, independently if the radio terminals are configured as RS or MS, the performance of the protected radio section are coincident with that of the RS.

However in this implementation, as detailed in ETS 300 635 [4], the radio repeater cannot support standard RST functionality (due to the conflict of two RS terminated by a single RST function).

If quality monitoring of single radio hops is required, it may be provided only in a proprietary way, e.g. through Forward Error Correction (FEC) activity.

The following issues are for further study:

- error performance monitoring in the case of STM-N transmission with  $N \geq 4$ .

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## Annex B (informative): Application of additional performance parameters for fault management and error performance management

In this annex some examples of applications of additional performance parameters are given.

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### B.1 Examples of RSPI and RPS events and counters behaviours

#### B.1.1 Received Level (RL) performance primitive, Received Level Tide Mark (RLTD) and Received Level Threshold Second (RLTS) performance events

Figure B.1a) shows one possible behaviour of the RL performance primitive as a consequence of the variation of the power level in a receiver.

The RL is associated to a threshold whose value determines the activation condition of a counter (RLTS) as shown in figure B.1b).

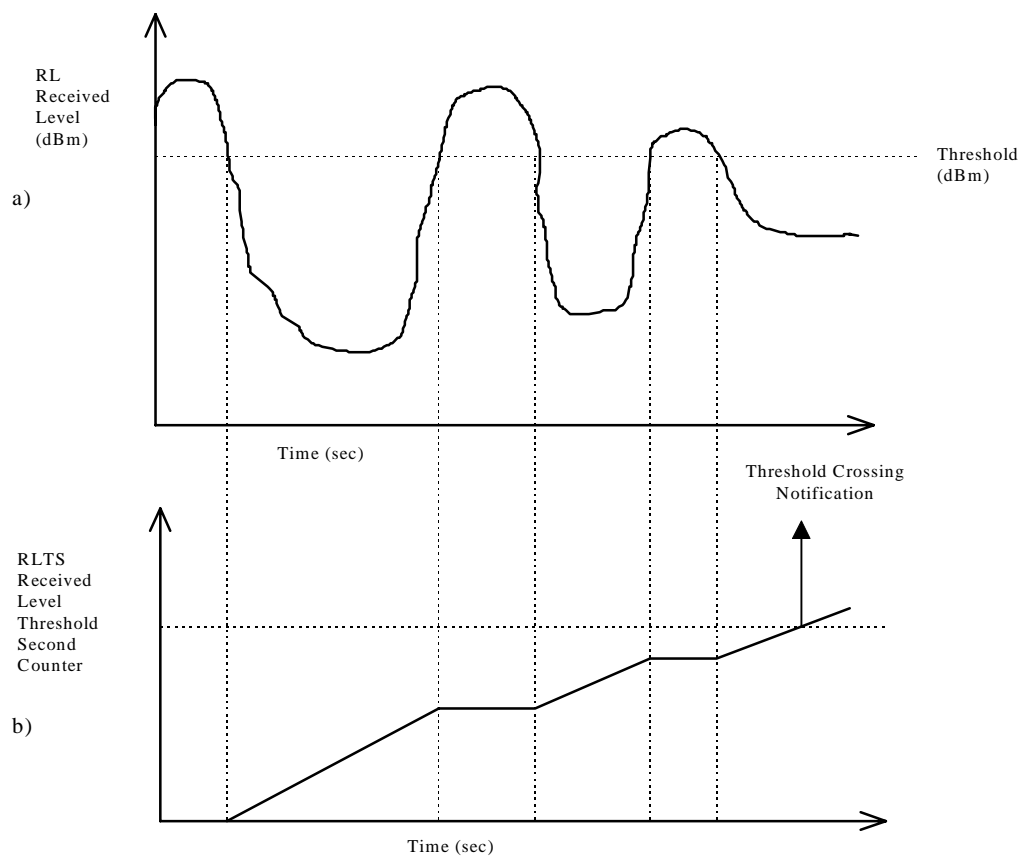
For a given observation period, this counter defines the time in seconds for which the RL has exceeded the given threshold.

A second threshold (figure B.1b)) may be associated to the RLTS counter for triggering a threshold crossing alarm indication.

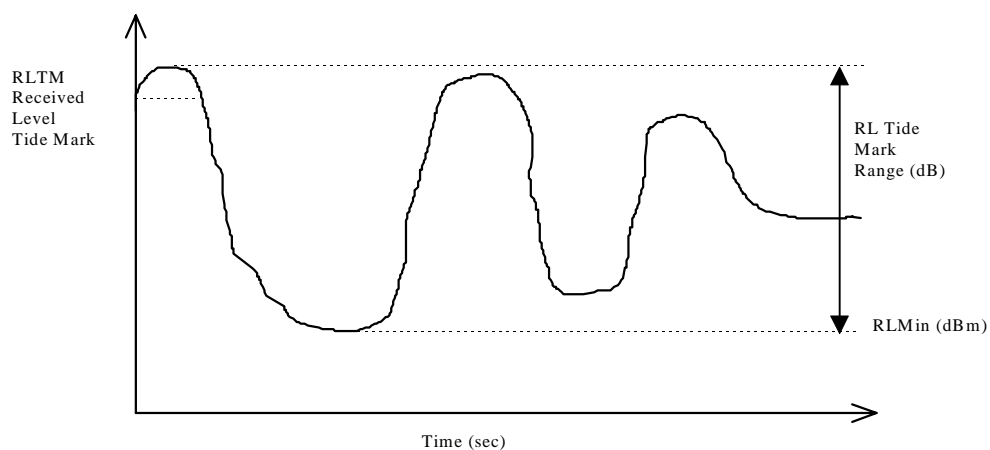
Figure B.2 shows the behaviour of the RLTD event associated to the RL behaviour defined in figure B.1a).

For a given observation period the RLTD is represented by two values indicating the maximum and minimum values assumed by the RL in that period.

Similar considerations are applied for the definition of the Transmitted Level (TL) primitive, the Transmitted Level Threshold Second (TLTS) and Transmitted Level Tide Mark (TLTD) events.



**Figure B.1: Received Level (RL) performance primitive and RLTS event counter**



**Figure B.2: RLTD performance event**

## B.1.2 RPS performance events

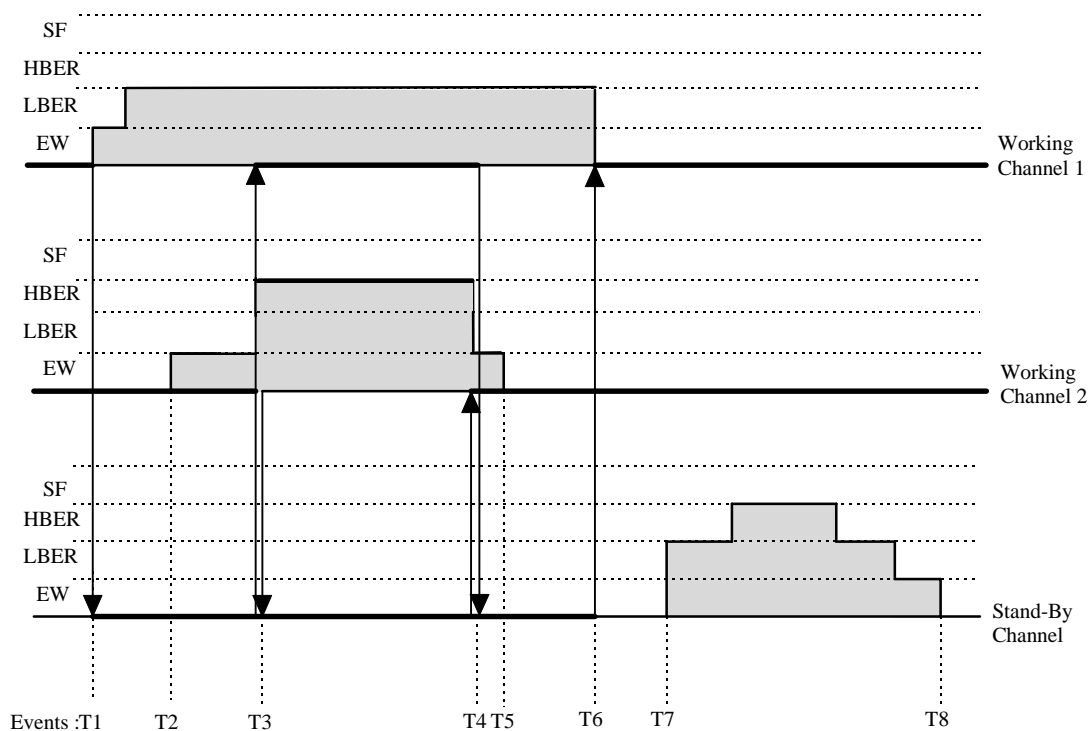
Figure B.3 shows one possible behaviour of a 2+1 switch in term of channel automatic switching requests and actual switching between working and stand-by channels.

For each channel, switching requests are represented by histograms indicating all the switching criteria that are active at a given time.

The traffic status of a channel is represented by a line depicted in bold if it is carrying regular traffic and by a thin line if not.

Actual switching between working and the stand-by channels are indicated by arrows.

Tables B.1, B.2 and B.3 define, for the working channels 1 and 2 and the stand-by channel respectively, the counter behaviours associated to each channel.



**Figure B.3: Behaviour of a 1:2 switch**

Table B.1: Switch counters behaviour for working channel 1

Events	Working channel 1 counters			
	PSAC	PSAD	FSRC	FSRD
T1	+1			
T1<t<T2		+n sec		
T2				
T2<t<T3		+n sec		
T3			+1	
T3<t<T4				+n sec
T4	+1			
T4<t<T5		+n sec		
T5				
T5<t<T6		+n sec		
T6				
T6<t<T7				
T7				
T7<t<T8				
T8				

Table B.2: Switch counters behaviour for working channel 2

Events	Working channel 2 counters			
	PSAC	PSAD	FSRC	FSRD
T1				
T1<t<T2				
T2			+1	
T2<t<T3				+n sec
T3	+1			
T3<t<T4		+n sec		
T4			+1	
T4<t<T5				+n sec
T5				
T5<t<T6				
T6				
T6<t<T7				
T7				
T7<t<T8				
T8				

Table B.3: Switch counters behaviour for the stand-by channel

Events	Stand-by channel counters	
	PSAC	PSAD
T1	+1	
T1<t<T2		+n sec
T2		
T2<t<T3		+n sec
T3	+1	
T3<t<T4		+n sec
T4	+1	
T4<t<T5		+n sec
T5		
T5<t<T6		+n sec
T6		
T6<t<T7		
T7		
T7<t<T8		
T8		

## B.2 Example of usage of additional performance parameters in case of fading phenomena and equipment fault

### B.2.1 Rain induced fading event

#### B.2.1.1 DRSS without ATPC

The SDH DRSS considered for this case is a high frequency link in 1+0 configuration.

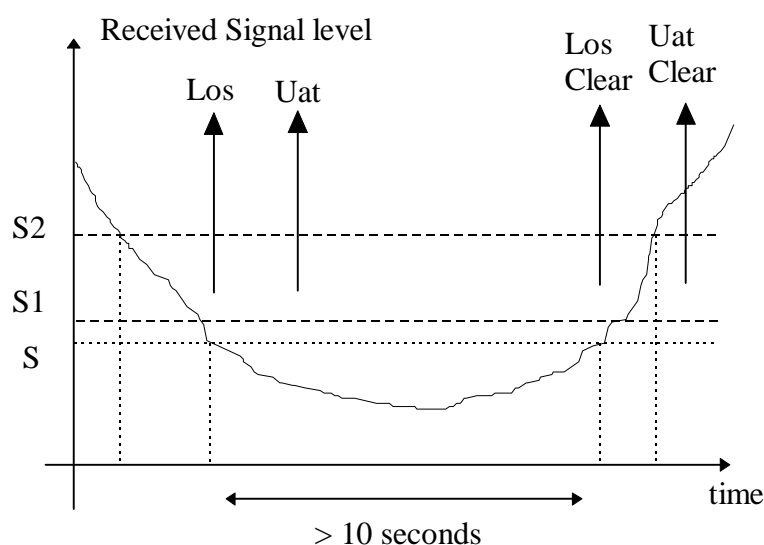


Figure B.4: Fading event on a high frequency DRSS due to precipitation

A LOS Communication alarm is sent to indicate the threshold S has been crossed.

In the case that it is not possible to discriminate between dLOS and dRxFail, a RxFail equipment alarm notification is sent instead of a LOS notification.

After ten consecutive SES an UnAvailable Time (UAT) notification is optionally sent to indicate the entering the unavailability state of the regenerator section.

After signal recovery from threshold S a LOS or RxFail clearing notification is sent.

The occurrence of the alarm clearing notifications should be enough to prevent immediate maintenance actions.

In the 15 minutes registers immediately before and after from the occurred notifications the following are additional indications of a signal fading:

- RLTM values close to each other (reduced RLTM range);
- RLTS-n counters with zero or very low values;
- SES counter close to zero value.

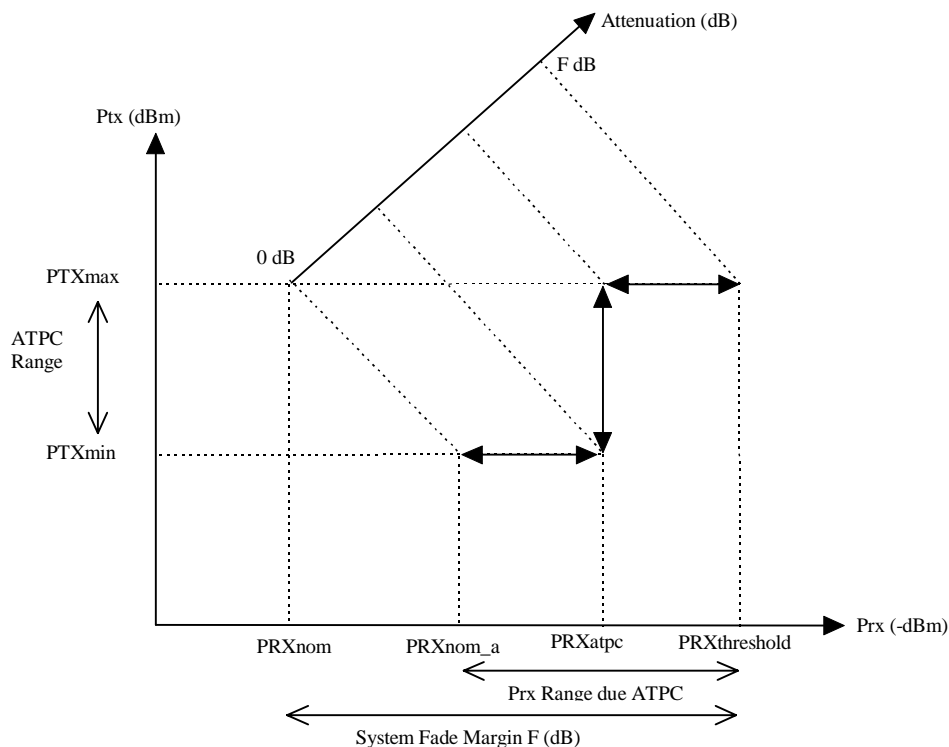
During the 15 minutes period alarmed, in the 15 minutes registers the following indications may be found:

- a RLTS-2 counter (associated to threshold S2) value greater than the RLTS-1 counter (associated to threshold S1) value, with RLTS-1 counter value close to the UAT counter value;
- ES counter with a value different from zero (ES occurred in an available time);
- SES counter with a value close to zero.

Additionally these types of events affect both transmission directions.

### B.2.1.2 Rain induced fading event: DRRS with the ATPC

The ATPC functionality, whatever is implemented i.e. continuous or discrete step modes, has the effect to reduce the received power level range as depicted in figure B.5.



**Figure B.5: Relationship between received and transmitted power level as function of attenuation in systems with continuous ATPC**

The ATPC is characterized by the ATPC range and defined as the difference between the maximum and minimum value of transmitted power.

At receive side the nominal value of the received power level ( $PRX_{nom}$ ) that would be obtained if the ATPC is not implemented (PTX equal to the maximum value), is replaced by a lower nominal value ( $PRX_{nom\_a}$ ) when ATPC is present and enabled.

This value defines the received Power level obtainable in unfaded conditions, i.e. attenuation equal to zero.

Under fading conditions, when the received level crosses certain levels ( $PRX_{atpc}$  for the case in figure B.5), the ATPC works by increasing (decreasing) the transmitted power level in case of attenuation increasing (decreasing).

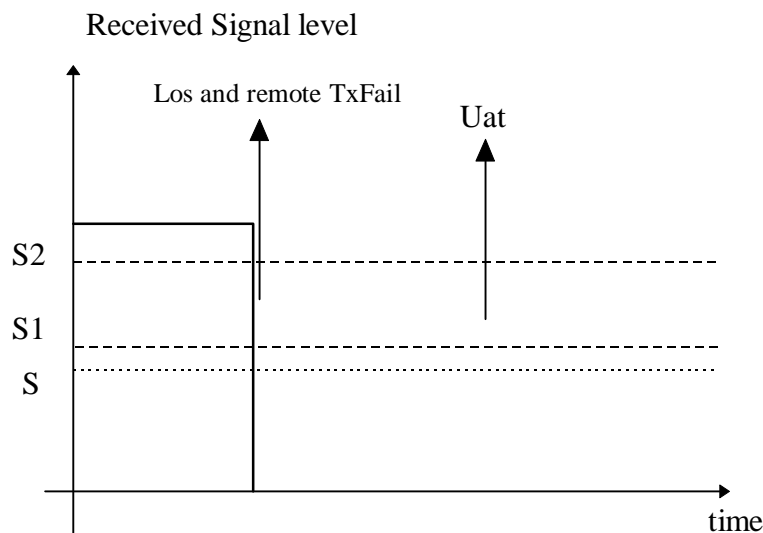
With PTX at the maximum value, higher attenuations will cause decreasing of received power level as it would be obtained without ATPC.

The case represented in figure B.4 has no differences in the case that ATPC is implemented.

If thresholds S1 and S2 have values lower than the  $PRX_{atpc}$  value the same behaviour is obtained in term of alarm notifications and clearing.

What can be verified is that during the period of the fading event the full range of PTX is spanned. This can be easily obtained by reading the TLTM values of the event period.

## B.2.2 Far end equipment failure at Tx side



**Figure B.6: Received power level behaviour in the case of far end Tx equipment fail**

Figure B.6 represents the behaviour of the received power level at near end when the far end terminal suffers a transmitter equipment failure.

The following considerations may be applied for any type of DRRS:

- in this case at near end (receive side) the same alarm notifications are sent as described in subclause B.2.1.

Additionally the following occurrences should indicate the necessity of rapid maintenance actions:

- TXFail alarm notification coming from transmission domain on the far end terminal;
- transmitter failure alarm notification coming from the equipment domain on the far end terminal;
- asymmetrical behaviour on the two transmission directions (no notifications coming from the opposite direction);
- RLTS-1 and RLTS-2 counter values with near identical values indicating a sudden decrease of the received power;
- near end SES and ES counter values close to zero (due to unavailability);
- absence of alarm clearing notifications as time goes on.

## B.2.3 Unexpected bad quality in a high frequency SDH DRRS

The DRRS layout is the same as in subclause B.2.1.

There may exist situations when a radio link may suffer from bad quality transmission, as indicated by ES/SES/BBE and UAS counter values, even if it is not highly affected by significant atmospheric fadings.

This may be the case when equipment degradations or margin reductions (due to interference or additional signal loss) occur.

It should be clear that neither the definition of an exhaustive list of cases is possible nor, for a given case, an exact cause can be found without any doubt.

In any case a more secure analyses can be done only on the base of the availability of a several number of measurement periods.

### B.2.3.1 Interference

Interferences from external sources act on a given link by reducing the system fade margin.

The exact effects in term of consequent reduction in quality transmission depend on the ratio between the levels of the wanted and interference signals and on the temporal variations of them.

A typical situation may be:

- no ES/SES/BBE or UAS events during unfaded periods indicated by low values of TLTM and RLTM ranges and zero values of those RLTS event counters with threshold values set close to the reference threshold that gives an ES or SES event;
- presence of ES/SES/BBE or even UAS events during weak faded periods indicated by TLTM and RLTM range values not fully spanned and RLTS event counts with values such that they do not justify the performance quality counter values;
- interference may behave asymmetrically in the two directions of transmission as a result, while TL and RL events should be similar, performance counter values should not.

### B.2.3.2 Additional signal loss

The received power level value is not an indication of the only atmospheric attenuation.

The measure takes also into account the antenna gains and losses due to feeders and branching filters.

Permanent additional losses due to these devices degradations result in a margin reduction.

In this condition a typical situation may be:

- during unfaded periods (RLTM and TLTM range values close to zero) the RLTM maximum value is permanently fixed to a value lower than the expected one and ATPC may be permanently active to a level higher than the normal value;
- depending on the set threshold value, RLTS and TLTS events may be permanently present indicated by counter values close to the number of seconds of the observation period;
- depending on the localization of the additional loss the above behaviour can affect one direction or both.

### B.2.3.3 Equipment degradation

Equipment degradations, to be distinguished by equipment failure that are permanent, may be the cause of sporadic additional ES/SES/BBE performance events.

These occurrences are generally implementation dependent and can, in principle, cover a wide variety of cases.

A typical situation may be:

- isolated ES/SES/BBE events with random distribution;
- uncorrelation with RL and TL events;
- asymmetrical behaviour in the two transmission directions;
- in some cases these events may be correlated to alarm notifications coming from equipment domain.

## B.2.4 Fading effects in a low frequency SDH DRRS

Low frequency DRRS also known as long haul systems may suffer from fading events which are frequency selective. These events may cause a quality degradation even if the received power level is not below a certain threshold. As a consequence ES/SES/BBE events cannot be strictly correlated with RLTS events as in the case of high frequency radio links.

However periods of signal fading may be identified by:

- TLTM and RLTM range values completely spanned;
- TLTS and RLTS event counts not equal zero;
- in some cases presence of LOS or DemFail alarm notifications.

Additionally it should be reminded that long haul DRRS are often implemented in 1: n and 2: n switching configurations with the switching section composed by two terminals and zero or more intermediate repeaters.

If this is the case ES/SES/BBE events may be referred to:

- each hops: there are  $(n+m) \times (r+1)$  hops in a m:n system with r intermediate repeaters;
- each protected section: there are n protected sections in a m:n system;
- each unprotected sections (channel links): there are n+m unprotected sections in a m:n system.

While RL and TL events are always referred to single hops, the additional performance parameters defined for the RPS can be correlated to the quality parameters of the protected and unprotected sections.

For such a system periods of fading activity may be identified by:

- simultaneous single hop RL and TL events as above defined and switching activity identified by the associated channel event counters.

Additionally, even if selective fading, for short periods, is time uncorrelated on a second basis among the different frequencies, on the base of larger periods, i.e. 15 minutes and to a major extent 24 hours, tends to be correlated.

This means that fading activity periods generally are reflected by similar behaviours of TL and RL event values on the hops associated to the same stations and on the RPS counter values of the different channels.

Moreover fading activity periods tend to affect similarly both transmission directions.

On the opposite, isolated ES/SES/BBE events always associated to a single hop and/or a single protected section may represent a valid indication of equipment malfunctioning or interference problems.

## B.2.5 Unexpected bad quality in a low frequency SDH DRRS

For the case in question it is supposed to have a generic  $n+1$  system composed by two terminal stations with an unspecified number of repeaters in between.

It is also supposed that quality performance monitoring is available for both all the hops and the protected sections.

The unexpected bad quality will be distinguished if it is referred to a single hop or to a protected section.

### B.2.5.1 Single hop

For the unexpected presence of ES/SES/BBE events on a single hop the same considerations and sub-cases as reported in subclause B.2.3 and subclauses may be valid.

The effect on the protected section may be indicated by:

- presence of PSAC and PSAD events on the channel served by this hop;
- absence or lower counter values of the same events on the other channels.

### B.2.5.2 Protected section

Under normal conditions the switching mechanism is able to counteract all types of performance quality events occurring on the single hops.

The presence of ES/SES/BBE events on a protected section (after the switching) may be caused by:

- simultaneous presence of error events on two channels;
- malfunction of the switching process.

The first case may be indicated by the presence of FSRC and FSRD events on the errored section.

The second case may be indicated by the absence (or low counter value) of the FSRC and FSRD events with presence of PSAC and PSAD events indicating switching activity with probable errors during the switching process.

## B.3 Example of maintenance principles

This clause gives some examples of usage of error performance counters, defects and additional specific performance parameters.

### B.3.1 High frequency DRRS in configuration without protection switching

In this example it is considered a high frequency DRRS without protection switching.

#### B.3.1.1 DRRS implemented as a Regenerator Section (RS)

The system is described in figure B.7. The DRRS is set-up as a RS with no protection switching. The working frequency is greater than 13 GHz, so it is mainly affected by flat fading due to hydrometeors (rain).

According to ETS 300 635 [4], TR 101 035 [15] and ETS 300 417 [7] the defects available are listed in table B.4. While in table B.5 the error performance parameters defined in EN 301 167 [6] and in the present document are shown.



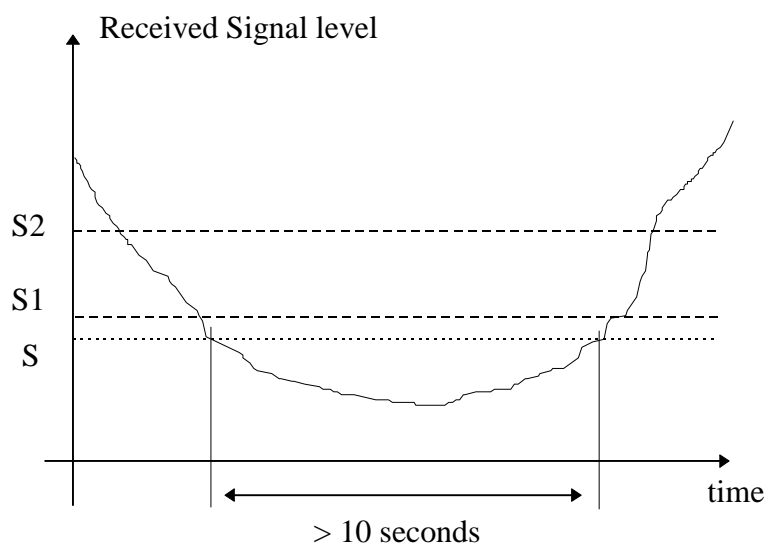
Figure B.7: Example of RS DRRS in configuration 1+0

Table B.4: Defects for the DRRS shown in figure B.7

Functional blocks	Defect	
	ITU-T Recommendation G.783 [1] ETS 300 635 [4] terminology	ETS 300 417 [7] TR 101 035 [15] terminology
RST	LOF	cLOF
RSPI	LossOfSignal(rx)	cLOS(rx)
	RxFail	cRxFail
	demLOS	cLOS(dem)
	demodulationFail	cDemFail
	LossOfSignal(mod)	cLOS(mod)
	modulationFail	cModfail
	TxFail	cTxFail
	TxLOS	cTxLOS

**Table B.5: Error performance parameters and additional performance parameters defined for the DRRS shown in figure B.7**

General error performance parameters for Regenerator Section (RS)	Additional performance parameters for RSPI functional block
SES	RL
BBE	RLTS-1
ES	RLTS-2
UAS	RLTM
	TL
	TLTS-1
	TLTS-2
	TLTM



**Figure B.8: Received signal level vs time due to flat fading**

The available information may be used for:

- fault detection and fault analysis;
- performance management for maintenance purpose.

#### B.3.1.1.1 Fault detection and fault analysis

The considered DRRS is effected by the attenuation of received signal due to rain. An example of variation in time of received signal level is shown in figure B.8. If the received signal level goes down level S, the system enters in unavailable state, because of the occurrence of more than 10 consecutive SES. At the same time a LOS defect (cLOS(rx) or cRxFail) occurs.

According to maintenance principles defined in ITU-T Recommendation M.20 [16] and according to fault management procedure defined in EN 301 167 [6], the defect occurrence has to be considered in order to undertake the correct maintenance procedure and to detect the fault cause. In this case the fault is due to propagation event, so no maintenance action has to be taken.

The additional performance parameters help us to detect the fault cause. In the following an example of a procedure for fault analysis is described.

### **DRRS without ATPC**

The threshold S1 is set close to the value S of received signal for which a SES event occurs.

When a LOS defect is declared the following situations are possible:

- 1) cLOS defect declared in the receiver terminal AND no defect detected in the transmission side of the far end terminal AND RL lower than S1 AND value of 15 minutes current register RLTS-1 different from zero THEN the LOS defect is due to rain.
- 2) cLOS defect declared in the receiver terminal AND a defect detected in the transmission side of the far end terminal THEN the LOS defect is due to a transmission fault.
- 3) cLOS defect declared in the receiver terminal AND no defect detected in the transmission side AND no cLOS detected on the far end terminal THEN the LOS defect is due to a receiver fault.

### **DRRS with ATPC**

The threshold S1 is set close to the value S of received signal for which a SES event occurs and threshold S2 is set to a higher value. Moreover a value of threshold greater than 10 seconds is set on the 15 minutes register RLTS-1 for the threshold crossing notification.

In the transmission side a threshold on the transmission level should be set at the limit of the range of ATPC, for example the threshold for TLTS-1 is set to indicate that the ATPC has reached the maximum value.

One possible example of usage of TLTS counter is reported in the following situation.

- cLOS defect declared in the receiver terminal AND no defect detected in the transmission side AND RL lower than S1 AND the value of 15 minutes current register TLTS-1 is different from zero THEN the LOS defect is probable due to rain.

The case of malfunctioning of ATPC is more complex. In fact if the ATPC does not work and the output power is fixed to the minimum value, so the fade margin is reduced and the transmission quality may be degraded. This situation is detected by means of analysis of error performance parameters (SES and BBE) in 15 minutes and/or 24 hours history registers. While if the output power is fixed to the maximum value only by means of analysis of additional performance parameters (such as RLTS and TLTS) 15 minutes and 24 hours counter history registers.

#### **B.3.1.1.2 Maintenance procedure based on error performance parameters**

EN 301 167 [6] defines the error performance management for maintenance purpose and the thresholding mechanism on 15 minutes and 24 hours SES, ES and BBE registers is defined.

This mechanism based on 15 minutes and 24 hours register allows to recognize the following situation:

- 1) failure not indicated by a defect;
- 2) errors in link design;
- 3) interference from other source;
- 4) ATPC that does not work correctly.

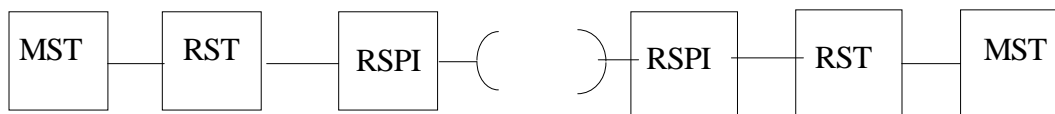
The analysis should be based on history registers and on threshold crossing notification of error performance current registers.

The previous example of malfunctioning may be recognized by means of the following considerations:

- Case 1) This situation may be indicated by periods affected by error performance degradation without fading activity, i.e. some periods with SES and/or BBE may be registered, but in the same period the analysis of the values stored in RLTS and TLTS history registers indicate no fading activity.
- Case 2) A wrong link design implies a system gain (margin) lower than the needed one, so an excessive number of SES, BBE and ES should be detected and they are caused only by propagation phenomena. This situation should be recognized using the history registers SES, BBE, ES, RLTS, TLTS. In fact in the 15 minutes and 24 hours periods affected by excessive SES, BBE and ES the value stored in the corresponding 15 minutes and 24 hours registers RLTS and TLTS should be different from zero (high values), while in the other 15 minutes and 24 hours period this value should be zero.
- Case 3) The interference from other sources should be recognized considering that periods with error performance degradation, do not correspond to periods of fading activity, as in Case 1. But interference may also reduce the system gain, so an excessive number of SES and/or BBE/ES is registered with a non excessive attenuation of the received signal. This situation is detected considering the value stored in the RLTS and TLTS history registers.
- Case 4) The use of TLTS in conjunction with RLTS history registers allow to detect if the ATPC does not work properly.

### B.3.1.2 DRRS implemented as a Multiplex Section

According to ETS 300 635 [4], TR 101 035 [15] and ETS 300 417 [7] the defects available are listed in table B.6, while in table B.7 the error performance parameters defined in EN 301 167 [6] and in the present document are shown.



**Figure B.9: Example of RS DRRS in configuration 1+0**

**Table B.6: Defects for the DRRS shown in figure B.9**

Functional blocks	Defect	
	ITU-T Recommendation G.783 [1] and ETS 300 635 [4] terminology	ETS 300 417 [7] and TR 101 035 [15] terminology
MST	AIS	cAIS
	MS-DEG	cDEG
	MS-RDI	cRDI
RST	LOF	cLOF
RSPI	LossOfSignal(rx)	cLOS(rx)
	RxFail	cRxFail
	demLOS	cLOS(dem)
	demodulationFail	cDemFail
	LossOfSignal(mod)	cLOS(mod)
	modulationFail	cModfail
	TxFail	cTxFail
	TxLOS	cTxLOS

**Table B.7: Error performance parameters and additional performance parameters defined for the DRRS shown in figure B.9**

General error performance parameters for RS	General error performance parameters for MS	Additional performance parameters for RSPI functional block
SES	SES	RL
BBE	BBE	RLTS-1
ES	ES	RLTS-2
UAS	UAS	RLTM
		TL
		TLTS-1
		TLTS-2
		TLTM

#### B.3.1.2.1 Fault detection and fault analysis

The relationship between LOS defect and additional performance parameters is the same as in subclause B.3.1.1.1.

#### B.3.1.2.2 Maintenance procedure based on error performance parameters.

The error performance monitoring for maintenance purpose should be based on the error performance parameters (SES, ES and BBE) at MS layer.

The considerations done in subclause B.3.1.1.2 are still valid.

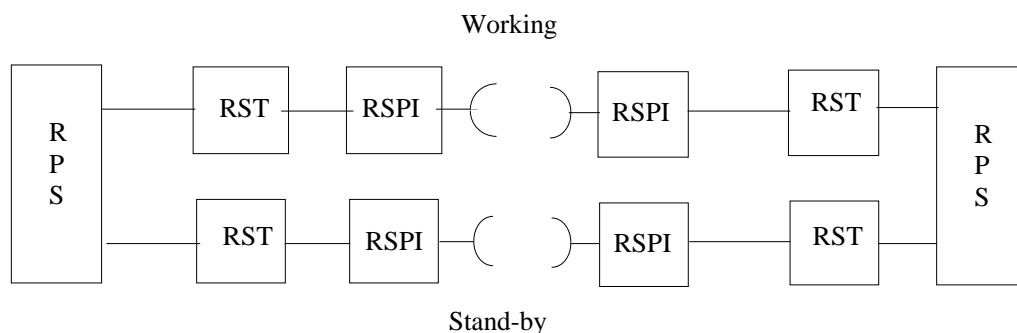
### B.3.2 DRRS with 1+1 protection switching

The RPS may be implemented according to a different topology as described in ETS 300 635 [4].

#### B.3.2.1 DRRS implementing protection type C

In this example it is considered the DRRS described in figure B.10. The DRRS is set-up as a RS with 1+1 protection switching type C. The working frequency is lower than 13 GHz, so it is mainly affected by selective fading.

According to ETS 300 635 [4], TR 101 035 [15] and ETS 300 417 [7] the defects available are listed in table B.8, while in table B.9 the error performance parameters defined in EN 301 167 [6] and in the present document are shown (the subscripts  $w$  and  $p$  indicate the defect and error performance parameters on the working channel and on the stand-by channel).



**Figure B.10: Example of RS DRRS in configuration 1+1**

Table B.8: Defects for the DRRS shown in figure B.10

Functional blocks	Defect	
ITU-T Recommendation G.783 [1] and ETS 300 635 [4]	ITU-T Recommendation G.783 [1] and ETS 300 635 [4] terminology	ETS 300 417 [7] and TR 101 035 [15] terminology
$RST_w$	$LOF_w$	$cLOF_w$
$RSPI_w$	$LossOfSignal(rx)_w$	$cLOS(rx)_w$
	$RxFail_w$	$cRxFail_w$
	$demLOS_w$	$cLOS(dem)_w$
	$demodulationFail_w$	$cDemFail_w$
	$LossOfSignal(mod)_w$	$cLOS(mod)_w$
	$modulationFail_w$	$cModfail_w$
	$TxFail_w$	$cTxFail_w$
	$TxLOS_w$	$cTxLOS_w$
$RST_p$	$LOF_p$	$cLOF_p$
$RSPI_p$	$LossOfSignal(rx)_p$	$cLOS(rx)_p$
	$RxFail_p$	$cRxFail_p$
	$demLOS_p$	$cLOS(dem)_p$
	$demodulationFail_p$	$cDemFail_p$
	$LossOfSignal(mod)_p$	$cLOS(mod)_p$
	$modulationFail_p$	$cModfail_p$
	$TxFail_p$	$cTxFail_p$
	$TxLOS_p$	$cTxLOS_p$
NOTE: The subscriber $w$ and $p$ indicates the defect on the working and on the stand-by radio-connection respectively.		

Table B.9: Error performance parameters and additional performance parameters defined for the DRRS shown in figure B.10

General error performance parameters	Additional performance parameters for RPS functional block	Additional performance parameters for RSPI functional block
$SES_w$	PSAC (note 2)	$RL_w, RL_p$
$BBE_w$	FSRC (note 2)	$RLTS-1_w, RLTS-1_p$
$ES_w$	PSAD (note 3)	$RLTS-2_w, RLTS-2_p$
$UAS_w$	FSRD (note 2)	$RLTM_w, RLTM_p$
$SES_p$		$TL_w, TL_p$
$BBE_p$		$TLTS-1_w, TLTS-1_p$
$Es_p$		$TLTS-2_w, TLTS-2_p$
$UAS_p$		$TLTM_w, TLTM_p$
$SES_{sw}$		
$BBE_{sw}$		
$Es_{sw}$		
$UAS_{sw}$		
NOTE 1: The subscriber $w$ and $p$ indicates the defect on the working and on the stand-by, radio connection respectively while the subscript $sw$ the switching protected section.		
NOTE 2: The additional performance parameter is defined only for the working radio connection in a 1+1 revertive protection scheme.		
NOTE 3: The additional performance parameter is not required in a 1+1 non-revertive protection scheme.		

### B.3.2.1.1 Maintenance procedure based on error performance parameters

EN 301 167 [6] defines the error performance management for maintenance purpose and the thresholding mechanism on 15 minutes and 24 hours SES, ES and BBE registers.

This mechanism based on 15 minutes and 24 hours register allows to recognized the following situation:

- switch malfunctioning;
- errors in link design.

The analysis should be based on a statistical analysis of history registers.

The previous examples of malfunctioning may be recognized by means of the following considerations:

Case 1) The switch malfunctioning may produce an anomalous number of SES, ES and BBE events outside the switching section in correspondence of fading activity. Moreover the quality of the single RS (stored in the error performance history registers of a single channel) is comparable with the quality of the protected section (stored in the error performance history registers of switching section). No correlation between SES/ES/BBE and FSRC and FSRD counters should appear.

Case 2) An underestimation of the propagation activity may produce:

- 2.1) a great number of switching events;
- 2.2) an improvement of the protection system minor than the expected one;
- 2.3) correlations between error performance parameters and FSRC and FSRD events.

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## Annex C (informative): Performance monitoring functional architecture

The depicted functional units reported in figure C.1 represent how this information is collected, treated and stored in generic registers. What is represented gives a functional view of the whole performance monitoring processing and should be considered implementation independent. The figure does not show the information flow from a managing system to the functional units nor defines how these units are seen in term of managed object class description.

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### C.1 Performance primitive and event generation.

Radio specific performance primitives together with the associated radio specific performance events are reported in the relevant clause of the main body of the present document.

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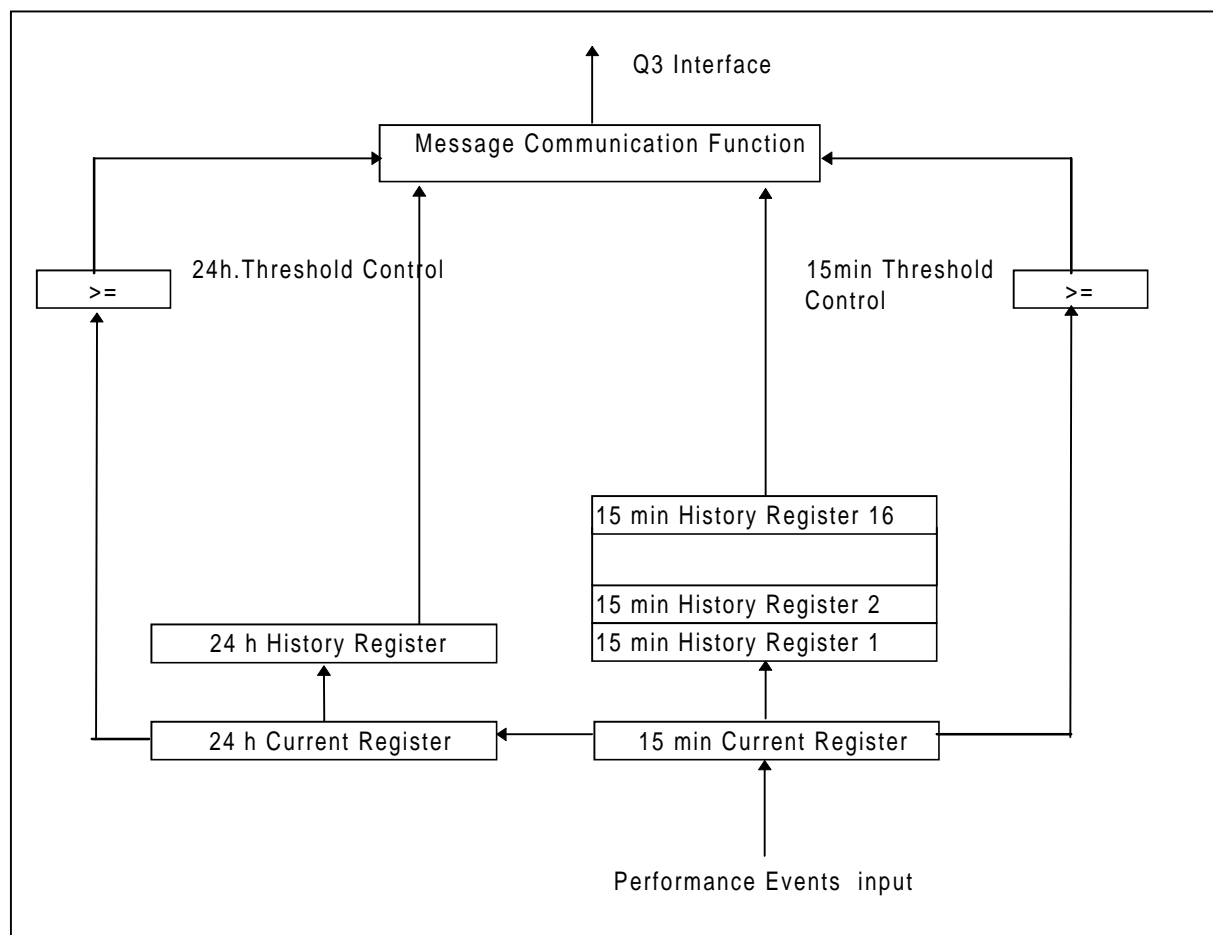
### C.2 Data collection, history and threshold treatment architecture

This clause gives a functional description on how performance events are collected and treated.

This clause describes the functional architecture of the radio specific PM information that flows from the functional blocks, which represents the information source, towards the management interface.

In order to give information consistent with SDH sections error performance monitoring (SES/ES/BBE events) it is necessary to have the same history treatment (15 minutes and 24 hours registers) as defined in ITU-T Recommendation G.784 [2] and EN 301 167 [6].

The functional description is reported in figure C.1.



**Figure C.1: Functional architecture for data collection, history and thresholding treatment**

## C.2.1 15 minute register

The performance events are counted in a counter per event. The events are counted for a time period of 15 minutes.

Second-by-second the input performance event values are stored by updating the previous second values. This register is called 15 minutes current register. The current register contains the number of events second-by-second from the reset instant to the present second.

At the end of the 15 minutes period the contents of current registers are transferred to the first of the history registers, with a time stamp to identify the 15 minute period (including the day), after which the current register is reset to zero.

Some counter values are passed, second-by-second, to the 15 minutes threshold crossing control unit for triggering threshold crossing notification.

At the end of the 15 minutes current register granularity period all the counter values, the tide mark values are passed to the 24 hours current register.

Optionally the same values are output to the Message Communication Function (MCF) to be forwarded to the managing system.

After that, a counter and tide mark reset occurs.

## C.2.2 24 hour register

The performance events are counted in a counter per event. The events are counted for a time period of 24 hours.

The 24 hours current register is used to store performance information on a 15 minutes period basis. The current register contains the number of events every 15 minutes period from the reset instant to the present 15 minute period.

At the end of each 15 minutes granularity period the 24 hours current register values and the tide mark values are updated and some counter values are forwarded to the 24 hours threshold crossing control unit for triggering threshold crossing notification.

At the end of the 24 hour period the contents of current registers are transferred to the first of the history registers (see subclause 5.2.4), with a time stamp to identify the 24 hour period, after which the current register is reset to zero.

At the end of the 24 hours current register granularity period the tide mark values are passed to the 24 hours history register.

Optionally the same values are output to the message communication function to be forwarded to the managing system.

After that a counter and tide mark reset occurs.

## C.2.3 Threshold crossing notification

The threshold mechanism generates an autonomous event report when the performance of a counted event exceeds a predetermined level.

The threshold may be set in the Network Element (NE) via the Operating System (OS). The OS should be able to retrieve and change the 15 minute and 24 hour thresholds.

The 15 minutes threshold crossing control receives, on a second basis, some counter values from the 15 minutes current register. Each counter value is compared with the associated threshold value. If the input value is equal or greater than the associated threshold value a threshold crossing notification command is forwarded to the MCF.

The 24 hours threshold crossing control receives, on 15 minutes basis, some counter values from the 24 hours current register. Each counter value is compared with the associated threshold value. If the input value is equal or greater than the associated threshold value a threshold crossing notification command is forwarded to the message communication function.

The detailed functioning of threshold mechanism is explained in EN 301 167 [6].

## C.2.4 History register

The 15 minutes history registers are used to store performance information of the recent 15 minutes periods.

At least 16 history registers are required.

At the end of a 15 minutes granularity period a wrapping mechanism is applied: the counter and event values of the  $n^{\text{th}}$  history register are transferred to the  $n+1$  the history register, the content of the last one is lost and the counter and event values of 15 minutes current register are transferred to the most recent history register.

On the managing system request the content of one or more history registers are output to the MCF to be forwarded to the system itself.

The 24 hours history register is used to store performance information of the most recent 24 hours period.

At least one history register is required. At the end of a 24 hours granularity period a wrapping mechanism is applied: the counter and event values of the 24 hours current register are transferred to the associated history register. On the consequence the previous content is lost.

On the managing system request the content of the history register is output to the MCF.

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## Bibliography

DEN/TMN-00006: "Radio specific performance monitoring information model for SDH radio".

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## History

Document history				
V1.1.1	December 1997	Public Enquiry	PE 9817:	1997-12-26 to 1998-04-24
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V1.1.1	September 1998	Publication		